In press: 2016 European Intelligence and Security Informatics Conference

Critical Review of Analytic Techniques

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***Abstract*— In this paper, we classify 75 analytic techniques in terms of their primary function. We then highlight where across the stages of the generic analytic workflow the techniques might be best applied. Importantly, most of the techniques have some shortcomings, and none guarantee an accurate or bias-free analytic conclusion. We discuss how the findings of the present paper can be used to develop criteria for evaluating analytic techniques as well as the performance of analysts. We also discuss which sets of techniques ought to be consolidated as well as reveal gaps that need to be filled by new techniques.**

***Keywords*—Intelligence analysis; structured analytic techniques; analytic training; analytic workflow**

I. Introduction

Intelligence analysis essentially involves collating and processing relevant data, and interpreting them in order to arrive at a judgment about a current or future situation. This is then communicated to users who may include decision-makers and other analysts [see 1, 2].

An array of analytic techniques have been developed and proposed to help intelligence analysts perform analytic tasks [see 3]. These techniques aim to encourage 'good' or 'best' practice in order to avoid errors and biases in thinking. Indeed, these techniques often form part of the core set of skills that are taught in analytic training programs [e.g., 4].

However, despite the potential value of these techniques in aiding analysts, there has been relatively little work on collating, categorizing and critically reviewing analytic techniques (for a notable exception see Heuer and Pherson, 2014)[3]. Furthermore, little has been said about where along the analytic workflow specific techniques might best be applied.

II. Goals of Present Review

The main goals of the present paper are to (1) identify the primary function(s) of analytic techniques, and (2) determine where along the analytic workflow these techniques may be best applied.

In order to achieve these goals, we identified 75 analytic techniques that have been recommended for intelligence analysts. These techniques were found on the basis of a search of the published literature. Other relevant analytic techniques may exist in unpublished form or in classified documents. Most (but not all) of the techniques are taken from Heuer and Pherson (2014)[3] who have led the way in exploring approaches for helping intelligence analysts perform analytic tasks. The full descriptions of the techniques are provided in Dhami, Belton and Careless (2016)[5].

III. Primary Function of Analytic Techniques

Efforts have been made by others to classify analytic techniques into meaningful categories [e.g., 6]. Heuer and Pherson (2014)[3] classified analytic techniques into eight categories according to *how* they help to achieve the goal of improving analysis. The eight categories they used are: decomposition and visualization, idea generation, scenarios and indicators, hypothesis generation and testing, assessment of cause and effect, challenge analysis, conflict management and decision support.

We argue that it is preferable to classify analytic techniques in terms of their different functions (i.e., purposes). We have identified 13 primary functions of the 75 analytic techniques identified. These primary functions are as follows:

1. Generating ideas/scenarios/questions/hypotheses/options
2. Clarifying
3. Determining usefulness of data
4. Critiquing
5. Reducing disagreement or reaching consensus
6. Identifying/monitoring patterns/trends over time
7. Identifying/understanding (non-causal) relations
8. Identifying/understanding cause-effect relations
9. Hypothesis testing
10. Forecasting/prediction
11. Deciding/choosing
12. Constructing message
13. Presenting message

Past categorizations such as those adopted by Heuer and Pherson (2014)[3] do not necessarily take into account the primary function of a technique. For instance, we would argue that Heuer and Pherson's 'decomposition and visualization' category should be relabeled as *clarifying* because the primary function of techniques that decompose and visualize data is to help the analyst understand the issues.

The present research was funded by HM Government.

Past categorizations also confound more than one primary function. For instance, Heuer and Pherson confound generation of hypotheses with their testing. Techniques that have a primary function of hypothesis or idea generation may not necessarily also involve hypothesis testing, and vice versa.

Finally, some techniques have been misclassified in the past. For instance, Heuer and Pherson classify indicators and indicators validation as generating 'scenarios and indicators', even though these two techniques have the primary function of *Identifying/monitoring patterns/trends over time* and *determining usefulness of data*, respectively. Similarly, Heuer and Pherson consider detecting deception as 'hypothesis generation and testing,' even though this technique is actually about *determining usefulness of data*. None of the techniques that Heuer and Pherson classify as 'assessment of cause and effect' actually have that as a primary function (e.g., key assumptions check is for *critiquing*, and outside-in-thinking is for *generating ideas, scenarios, questions, hypotheses, options*).

In Table 1 below, we classify all of the 75 analytic techniques in terms of their primary functions. The majority of these techniques have only one primary function, and those with more than one primary function are asterisked.

TABLE I. PRIMARY FUNCTION OF ANALYTIC TECHNIQUES

Primary function	Analytic technique
1. Generating ideas, scenarios, questions, hypotheses, options	• Alternative futures analysis • Centre of gravity analysis • Classic quadrant crunching • Cone of plausibility • Environmental scanning • Foresight quadrant crunching • Individual brainstorming • Morphological analysis • Multiple hypotheses generator • Multiple scenarios generation • Nominal group technique (NGT) • *Outside-in-thinking • Quadrant hypothesis generator • Simple hypotheses • *Simple scenarios • Starbursting • Structured brainstorming • Virtual brainstorming
2. Clarifying	• *AIMS (Audience, issue, message and storyline) • *Concept map • Customer checklist • Getting started checklist • Issue redefinition • *Mind map
3. Determining usefulness of data	• Deception detection • Diagnostic reasoning • Filtering • Indicators validation • Information extraction and weighting • Paired comparison • Quality of information check • Ranked voting • Weighted ranking
4. Critiquing	• Devil's advocacy • Key assumptions check • Premortem analysis • *Pros-cons-faults-and-fixes • Red team analysis • *Structured self-critique
5. Reducing disagreement/ reaching consensus	• Adversarial collaboration • *Delphi method • *Structured debate • Team A/team B
6. Identifying/monitoring patterns/trends over time	• Chronologies and Timelines • Gantt chart • *Indicators • Process map
7. Identifying/understanding (non-causal) relations	• *Concept map • *Mind map • Network analysis • Sorting • Venn analysis
8. Identifying/understanding *cause-effect* relations	• Backcasting • Bow-tie method • Complexity manager • Cross-impact analysis • Cultural topography • Force field analysis • High impact/low probability analysis • *Outside-in-thinking • *Simple scenarios • What if? Analysis
9. Hypothesis testing	• Analyses of competing hypotheses (ACH) • Argument mapping • *Indicators • Radar chart • Structured analysis of competing hypotheses (SACH)
10. Forecasting/predicting	• Bayesian forecasting • *Delphi method • *Game theory • Impact matrix • Intelligence preparation of the battlefield/environment (IPB) • Lockwood analytical method for prediction (LAMP) • Prediction markets • Red hat analysis • Role playing • Structured analogies
11. Deciding/choosing	• Decision matrix • Decision tree • *Game theory • *Pros-cons-faults-and-fixes • SWOT analysis
12. Constructing message	• *AIMS (Audience, issue, message and storyline) • *Analyst's roadmap • *Structured debate • *Structured self-critique
13. Presenting message	• *AIMS (Audience, issue, message and storyline) • *Analyst's roadmap

IV. Analytic Techniques Across the Analytic Workflow

Heuer and Pherson (2014)[3] classified analytic techniques into 12 'key tasks' that analysts perform. These are: define the project, get started, examine and make sense of the data, explain a recent event/assess the most likely outcome of an evolving situation, monitor a situation to gain early warning, generate and test hypotheses, assess the probability of deception, foresee the future, challenge your own mental model, see events from the perspective of the adversary or other players, manage conflicting mental models or opinions, and support a decision maker. However, this classification confounds the function of a technique with the analytic task and/or stage of the workflow where it might be applied.

In addition, Heuer and Pherson's 'key tasks' are not ordered logically over the analytic workflow, and some aspects of the workflow are missing, while others are added that may not always be there. For instance, assessing the probability of deception may not be a distinct stage of the analysts' workflow, and may not apply to all workflows. By contrast, the task of obtaining existing data is usually part of the analysts' workflow, but is absent from Heuer and Pherson's list of key tasks.

Finally, some of Heuer and Pherson's classification is tautological. For instance, decision support is classified as a technique for supporting a decision maker.

We arrange the 75 analytic techniques across the analytic workflow according to their primary function. There are many instantiations of the workflow and for present purposes we use a model of the generic analytic workflow developed and validated by Dhami and Careless (2015)[1]. The workflow is generic because it applies to different sorts of analysis (e.g., HUMINT, SIGNIT, as well as single and multi-source), conducted individually or in teams, and for different purposes (e.g., strategic, tactical).

The workflow is separated into at least six meaningfully different stages of activity that follow from one another. These stages are: capture requirements, plan analytic response, obtain data, process data, interpret outputs, and communicate conclusions.

The *capture requirements* stage is about understanding the customer's viewpoint, what outcome the customer wants to achieve, and challenging this if necessary. The *plan analytic response* stage is about identifying the analytic lines/hypotheses, the methods for evaluating these, and how effective and efficient they may be, as well as prioritizing how to proceed. The *obtain data* stage is about extracting and selecting the relevant data from the most appropriate sources in the most efficient manner, as well as establishing new sources of data if necessary. The *process data* stage is about manipulating the data using relevant analytic tools and techniques, including reformatting it. The *interpret outputs* stage is about evaluating alternative explanations for the data, constructing a logical argument to support the conclusion(s) drawn, determining the level of confidence in these conclusions, and identifying any ambiguities. Finally, the *communicate conclusions* stage is about communicating the outcome of analysis in a clear and meaningful format, distinguishing fact from inference, and expressing uncertainty and confidence.

Some could argue that many of the primary functions are applicable at all stages of the workflow. For present purposes, we have attempted to highlight which primary functions are *central* to performing the main activities at each stage of the workflow. Table 2 shows the stages of the analytic workflow where each of the 75 analytic techniques has been placed, depending on its primary function.

TABLE II. Analytic Techniques Across the Generic Analytic Workflow

Stage of workflow	Primary function of technique
1. Capture requirements	• Clarifying
2. Plan analytic response	• Generating • Identifying/monitoring patterns/trends over time • Deciding/Choosing
3. Obtain data	• Generating
4. Process data	• Determining usefulness of data • Identifying/monitoring patterns/trends over time • Identifying/understanding (non-causal) relations • Identifying/understanding *cause-effect* relations
5. Interpret outputs	• Critiquing • Reducing disagreement/reaching consensus • Hypothesis testing • Forecasting/predicting • Deciding/Choosing
6. Communicate conclusions	• Constructing message • Presenting message

V. Discussion

In this paper 75 analytic techniques were classified in terms of their primary function. This consequently highlighted where across the stages of the generic analytic workflow the techniques might be best applied.

Most (i.e., 63) of the 75 techniques had *one* clear primary function (e.g., hypothesis testing). When the techniques were organized across stages of the analytic workflow according to their primary function, it was evident that there is an abundance of existing analytic techniques for some stages (e.g., interpreting outputs), but there are few techniques available in the published literature for other stages (e.g., obtaining data).

Importantly, most of the techniques have some shortcomings, some of which can be overcome with, for example, better specification. None of the techniques guarantees an accurate or bias-free analytic conclusion. Many of the techniques rely on the skills of the analyst and his/her subjective input. Thus, the outputs of these techniques will be as good as analysts' skills in applying the technique and the quality of the input.

There are several avenues for further exploration of analytic techniques which can be supported by the findings of the present paper. First, although the underlying assumption is that analysts using these techniques will perform better than those that do not, the effectiveness of these techniques has rarely been empirically tested (for exceptions of tests in the intelligence domain, see [7,8,9]). Therefore, there is an urgent need to empirically test the effectiveness of these analytic techniques [10]. The present paper highlights a criterion on which a technique could be tested (i.e., by its primary function), and suggests the sort of analytic task that could be used to test a technique i.e., a task at the stage of the workflow where that technique is best applied. In addition, the present paper can guide assessment of the *relative* effectiveness of different techniques with the same primary function and applied at the same stage of the workflow.

Second, techniques should be developed to help analysts perform other functions that are necessary for best practice (e.g., effective and efficient practice) along the analytic workflow. Specifically, techniques that enable analysts to more effectively and efficiently search for data could also be developed. Ideally, techniques would be usable by both individual analysts and groups, and would not necessarily require formal training, and would require little resources and time required. This would allow analysts to work both effectively and efficiently.

Third, and related to the above point, once there are a sufficient number of effective techniques that can be applied at each stage of the workflow, effort could be made to consolidate techniques with similar functions. This would result in a manageable number of analytic techniques.

Fourth, the present paper can be used to develop performance evaluations for analysts. For instance, are analysts using recommended practices at each stage of the workflow? How skilled are analysts at generating scenarios, critiquing ideas, identifying and monitoring patterns/trends over time, testing hypotheses and forecasting/prediction, presenting a message, and so on?

Finally, the findings of the present paper can be used to inform the development of analytic technology that aims to support analysts in their work. Analytic tools need to focus on supporting analysts to perform functions that are necessary for each stage of the analytic workflow, and so these tools need to incorporate the relevant techniques for performing these functions.

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